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EDITORIALS.

THE scope of the work of the United States Geological Survey was enlarged the present year by the adoption of an amendment to the appropriation bill providing for the gauging of the water supply of the United States, and for the investigation of the artesian water areas. The demands made upon the Survey from time to time for information concerning the water resources of the country are far greater than it is able to meet. The demand is especially from the West ; but numerous calls also come in from the East relative to the available water supply for power, and in some areas for irrigation. Response to the inquiries made requires not only a broad knowledge of the topography, geological structure, and meteorological conditions of the regions involved, but also more or less familiarity with the local conditions governing the distribution and character of the available water. These inquiries are made by all classes. They come from farmers seeking to provide water for domestic use, and for irrigation ; from individuals seeking artesian water supply and water power ; from municipal organizations ; and from members of congress having in view legislation concerning the utilization of streams flowing across state boundaries.

The general government has absolute title to nearly one third of the area of the United States, excluding Alaska. With the exception of certain areas within the Indian Reservations, the public lands of the West are mainly within the arid or semi-arid region. There is only enough water for the irrigation of a small proportion of the rich soil. Whether it be received from artesian sources or from precipitation direct, the government is still far from knowing the total amount available, or the best method of its utilization.

In order to throw light upon one of the many phases of the

inquiries concerning the water resources, a thorough investigation was made, under the direction of Major Powell, as to the population of the lands of the national domain. The result shows that settlement has followed the streams of the great west to a remarkable degree, and that it has clustered about the foothills of the higher mountain ranges, which, from their abruptness of topography, insure a perennial supply of water for irrigation. There is hardly a spring, creek, or small river, whose waters are not utilized by the farmer. As a consequence, the surface of the great desert of arid land is everywhere dotted with oases. The water which is thus utilized is that which is most readily available. There is much that is still unemployed. Both the great supply of storm waters, and the underground supply, are scarcely touched. The utilization of this unappropriated water is the first condition for the further development of the arid and semi-arid lands. In order that it may be utilized, a careful investigation should be made, in order to furnish the information which is needful before new enterprises can safely be entered upon.

In the past, the hydrographic work of the Survey has been limited, because of the small sum available for gauging the streams, and for studying the various problems involved. Such results as have been secured were rather an incidental result of the brief irrigation survey which was practically suspended in 1891. The scope of the requests for information shows the popular appreciation of the best work in this direction. From this standpoint the inquiries are encouraging. At the same time they are embarrassing, in that it is assumed that the Survey has extended its investigation over the whole field, when, as a matter of fact, the work has been carried on in a restricted way in but a few of the more important localities.

The nation as a whole is interested in the question of its water resources, as vital to the future of the public lands. It is also interested in the general question of water for domestic purposes, especially in thickly settled districts. The economic and effective search for waters for this purpose involves a knowl-

edge of all of the factors entering into a thorough hydrographic investigation. In the search for artesian waters, thousands of dollars have been wasted in places where a thorough knowledge of the geological structure would have prevented such waste. Each year this fact is being better appreciated, and expert opinion is more and more sought, both in connection with the search for artesian water, and in the utilization of water power.

The hydrographic work is not only intimately related to geology and topography, but also demands data from the records of climatic oscillations. The latter may be obtained from the records of the Weather Bureau, but in other respects the work is essentially a survey, and should be prosecuted in the most economic manner possible. The organization of the department of hydrographic work under the present limited appropriation is under the charge of Mr. F. H. Newell, who is assisted by Mr. Arthur Davis. Both of these gentlemen are trained topographers, and have had long experience in such hydrographic work as is contemplated by the Survey. At present they are largely engaged upon the special study of the water supply of the great arid and semi-arid region of the interior, employing local assistance wherever parties are found who are interested in the work. A large amount of this assistance is voluntary, so that they are able to obtain much more extensive results than would otherwise be possible with the resources at command. The railroads, especially, are giving much assistance by having their bridge tenders read the river gauges that have been set up under the direction of Mr. Newell.

The value of this work is beyond question, and since it is so closely related to geology, it appears to be strictly germane to the work of the Survey.

R. D. S.

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THERE is another project under consideration by the Director of the Survey that will be of practical value to the people of the country. It is proposed to establish a laboratory for the study of materials entering into the construction of highways. At present there is a decided movement in the country towards the

betterment of roads. This movement has not yet taken a national character, but it is believed that, by establishing a laboratory in connection with the National Survey, where information can be given as to the character of the material best adapted to road construction, a great impulse may be given to the improvement of highways.

It is well known that in many districts great expense has been incurred in building roads, with the result of producing dusty roads in summer and muddy roads in winter. This outcome is the result of ignorance in regard to the character of the rock necessary for the production of good roads. Inferior materials have sometimes been used, when, in the immediate vicinity, there were other materials which, alone or in combination, would have produced a solid road-bed. Such failure results in discouragement, and is detrimental to further progress. The requirements which relate to the building of a road are not more complicated than those which relate to the building of a roof. The main questions have to do with the choice and manipulation of materials. It is clearly within the province of the Survey to gather and distribute accurate information concerning the value and location of rocks which may serve a good purpose in the construction of roads. To a great extent these inquiries can be made in the ordinary work of the Survey, with but a small addition to the present cost of its operations.

A large part of the country, including the greater portion of the southern states, and some portions of the Mississippi basin, has been thought to be essentially destitute of materials suitable for the construction of good roads. The inquiries that have been made by geologists, especially by Professor Shaler, have shown that in many places within these regions there are hidden deposits of gravel, and other sorts of rock, which, when properly used, might give excellent highways, and that around the margin of this great area, often within the limits of convenient railway distribution, there are abundant supplies of rock well fitted for such use. It only remains to discover the supply of such stone as is cheapest and best for the use of each region.

This information can only be obtained in practical form for each district, as the work of the Survey advances. Professor Shaler has prepared a paper on the subject of geological highways, which will be printed in the annual report of the Director of the Survey for 1893-4. For more detailed information, it is proposed that the various road commissioners send to the Survey samples of such rocks and gravels in their immediate vicinities as are believed to be valuable for road construction.

A laboratory for inquiry into the value and use of materials which may be useful in the construction of highways was established in connection with the Massachusetts Road Commission at the scientific department of Harvard University. This was established especially to meet the needs of Massachusetts. The results of the first year's work have shown clearly that the laboratory will be of great service to the people. It is possible that each state should establish a laboratory, though this would lead to great expense, since the amount of work to be done after a year or two of study would be relatively small in each, and the results obtained by divers observers and methods would lack the unity which give a national value.

The work of the laboratory should be arranged so as to obtain information (1) as to the resistance of the material to blows such as are inflicted by the feet of draft animals and by carriage wheels; (2) as to the cementation value of the dust which is made when the bits of stone are placed upon the road and driven together by the weight of the roller; (3) as to the extent to which the stone is likely to be penetrated by water, which, on freezing, will break and disturb the road-bed. When preliminary tests have shown that any given material is likely to be valuable, it may be desirable to make further and more thorough tests by paving a square rod of some street where the amount of traffic is sufficient to give it a thorough trial.

Experience has shown that many kinds of rock which are not suitable for road building when used alone, may be combined with other materials in such wise as to give good results. Thus certain quartzites, which, though very hard, do not, when crushed,

form a binding cement of good quality, may be made to do good service in road construction when mixed with a small quantity of rock powder obtained from some other stone. As this powder need not exceed one tenth of the material used in road construction, it need not involve great cost, even if brought from a considerable distance.

Professor Shaler has called attention to the use of bricks for highways. They have been used for centuries in Holland, and it now seems likely that in the lowlands of the South this kind of pavement may come to be of great value. This makes it important that the laboratory should include in its investigations a careful study of the clays of the country, with reference both to distribution and burning qualities. Much information is at hand concerning the clays of the country, but little attention has been paid to this phase of their use.

During the present year an officer of the Survey will be detailed to take charge of the investigation of highway material in the laboratory at Cambridge, Mass. The establishment of a national laboratory will be brought to the attention of congress, and a request made for a suitable appropriation. The entire expense would probably not exceed \$15,000 for the first year, and \$10,000 a year thereafter. It would seem that such a laboratory would speedily become a source of public information concerning highways, and that it would prove to be of great value to the country.

R. D. S.